DISPLAY PRIVACY FOR ENHANCED PRESENTATIONS WITH REAL-TIME UPDATES

BACKGROUND OF THE INVENTION

1. Technical Field:

The present invention relates in general to a computer system having double display devices, such as one or two cathode ray tubes (CRTs), or one or two liquid crystal displays (LCDs), or a mix of one CRT and a LCD, for example. In particular, the present invention relates to a computer display system wherein either identical or different images may be displayed simultaneously to a user on a local LCD display device and to an audience on an external CRT device.

2. Description of the Related Art:

As utilized herein, a "dual display computer system" encompasses, in general, the following functionality. The dual display system is incorporated in a portable computer such as a lap-top computer having a built-in display panel that is the first part of the dual display. The dual display system is provided with a means for connecting a second external display device such as a CRT display thereto. When the external display device is connected, the dual display computer system can display an identical image on its own display panel and on the external display unit at the same time. Such dual display systems are commonly utilized for providing presentations wherein a presenter can simultaneously face an audience and view a local display of a sequence of display screens while providing the same display screen sequence to an audience via the external display device.

With reference to **FIG. 1**, there is depicted a block diagram of a conventional dual display computer system **100**. Although not explicitly shown in **FIG. 1**, it will be understood by those skilled in the art that such a system may be incorporated within personal computer

systems such as portable lap-top computers, which are particularly useful for providing graphic display presentations. The internal video display data path processing functionality of dual display computer system **100** essentially includes a central processing unit (CPU) **115**, a video memory device **112**, a video display controller **110**, and a digital-to-analog converter (DAC) **106**.

In typical implementations, video display controller **110** and video memory device **112** are incorporated on a video adapter board (not depicted) that plugs into a personal computer. As depicted in **FIG. 1**, dual display computer system **100** further includes a local LCD device **104** for providing an onboard video display to a local user, and an external CRT display device **102** for providing an alternate video display to an audience, for example. The display capabilities of a personal computer in which dual display computer system **100** is implemented depend on both the logical circuitry (provided by video display controller **110** and video memory **112**) and the display apparatus connected therewith (LCD device **104** and CRT display device **102**). An external interface bus cable **108** connects CRT display device **102** with video display controller **110**. DAC **106** converts digitally encoded images into analog signals that can then be displayed by CRT display device **102**.

Modern video adapters contain their own memory, such as video memory device **112**, so that the host computer's random access memory (RAM) is not depleted by graphic display storage. In addition, although not depicted in **FIG. 1**, most video adapters have their own graphics coprocessor for performing graphics-related computations. As illustrated in **FIG. 1**, video memory device **112** further comprises a frame buffer **114** having one or more output ports for providing a data path from video memory **112** to LCD device **104** and CRT display device **102**.

In the configuration depicted, dual display computer system **100** includes switching means (not depicted) associated with frame buffer **114** for determining whether to send video data to LCD device **104** only, CRT display device **102** only, or both LCD device **104** and

CRT display device **102** simultaneously. Typically, a dual display computer system does not include an option to freeze a current graphic display on CRT display device **102** while providing a next displayed item on LCD device **104**. This is a significant practical limitation since it prevents a person providing a sequential visual presentation to an audience from previewing a locally displayed copy of the graphics file (usually an upcoming graphic) prior to actually displaying it to the audience.

A possible solution to this problem is to incorporate additional data path control circuitry to the video adapter to provide the requisite independence between the local LCD display and an external CRT display. Two such data path intervention techniques are described in U.S. Pat. No. 5,977,933, issued to Wicher et al. and U.S. Pat. No. 5,764,201, issued to Ranganathan. The split display method disclosed by Wicher et al. employs independent clocking to each display to enable a simultaneous display of different images as well as simultaneous display of the same image. However, extensive multiplexing and timing circuitry must be added to the video adapter card to implement the independent clocking. Another approach to providing a split display capability is disclosed by Ranganathan, wherein different data path formats are utilized to provide independent display capabilities. Dual data paths from video memory are applied to multiplexing circuitry, which either act in unison to display the same image on both the local LCD panel and the external CRT, or separately so that different images may be displayed on each of the displays. As with the technique described by Wicher, however, substantial additional multiplexing overhead circuitry must be added. In addition, the complexity of the video data path is greatly increased to accommodate two video data formats.

An alternative approach for providing a split display capability entails freezing a currently displayed graphic on one display unit (external CRT) while permitting the display unit (local LCD) to display a different graphic. Such an approach is set forth by Tsakiris in U.S. Pat. No. 5,736,968, wherein is described a computer based presentation system that allows a presenter to view on a monitor associated with a computer an image prior to its

display on a television monitor or projection system to an audience. The system described therein includes a video frame buffer having an input coupled to a video port of the computer for receiving a video signal generated by the computer. The buffer captures and stores in memory a frame carried by the video signal. An output of the video buffer is connected to a video display adapter for continuously converting the stored image frame to a second video signal for transmission to the television monitor for display to an audience.

The additional hardware required to implement the system set forth by Tsakiris does not affect the extant video display adapter associated with the local display, and therefore for split display applications requiring independence to the extent that a locally displayed image can be changed while the external display is held static, the system described by Tsakiris may be preferable to those systems disclosed by Wicher et al. and Ranganathan. However, additional hardware overhead is required in that an additional video display adapter for the external display must be added.

It can therefore be appreciated that a need exists for an improved technique for simultaneously displaying different images on a local display device and an external display device without adding duplicate video display adapter functionality. The present invention addresses such a need.

SUMMARY OF THE INVENTION

An apparatus and method within a display subsystem for replacing a first video image on a local display while simultaneously maintaining the first video image on an external display are disclosed herein. The method entails configuring a first buffer address register accessible by a display controller to locally display data pointed to by the first buffer address register, and a second buffer address register accessible by the display controller to display within an external display device data pointed to by the second buffer address register. An active frame buffer stores graphic image contents for a local display. The first and second buffer address registers are programmed to point to the primary frame buffer during dual display mode. Responsive to selecting split display mode, the contents of the primary frame buffer are copied to a static frame buffer. Finally, the second buffer address register is set to point to the static frame buffer.

All objects, features, and advantages of the present invention will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a block diagram illustrating a conventional dual display computer system;

FIG. 2 is a block diagram depicting a split display computer system as configured during dual display mode in accordance with a preferred embodiment of the present invention;

FIG. 3 is a block diagram illustrating the split display computer system shown in **FIG. 2** operating in split display mode in accordance with a preferred embodiment of the present invention;

FIG. 4 is flow diagram depicting steps performed within a computer display system in selecting dual display and split display modes in accordance with a preferred embodiment of the present invention; and

FIG. 5 is a flow diagram illustrating steps performed within a computer display system during split display mode in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

This invention is described in a preferred embodiment in the following description with reference to **Figures 2** through **5**. While this invention is described in terms of the best mode for achieving this invention's objectives, it will be appreciated by those skilled in the art that variations may be accomplished in view of these teachings without deviating from the spirit or scope of the present invention.

Although, the present invention will be described herein in terms of a particular system and particular components, one of ordinary skill in the art will readily recognize that this method and system will operate effectively for other components in a data processing system. The present invention will be described in the context of a computer-aided display system comprising a local liquid crystal display (LCD) for providing a local user (presenter) a visual display of a graphic image file stored within a portable personal computer. As described with reference to the figures herein, the computer-aided display system further includes an external cathode ray tube (CRT) display device for providing a graphic image display to an audience. However, one of ordinary skill in the art will readily recognize that the present invention is also applicable for any situation in which a computer-aided dual display capability is implemented.

With reference now to the figures wherein like reference numerals refer to like and corresponding parts throughout, and in particular with reference to **FIG. 2**, there is depicted a block diagram illustrating a computer display system **200** as configured during dual display mode in accordance with a preferred embodiment of the present invention. Although not explicitly shown in **FIG. 2**, it will be understood by those skilled in the art that such a system may be incorporated within a personal computer such as portable lap-top computers commonly utilized for providing computer-aided display presentations. Computer display system **200** includes a video display controller **210** and a frame buffer **214**. As illustrated in **FIG. 2**, frame buffer **214** is incorporated within a dedicated video memory device **212** where

an image is stored and manipulated, independent of the computer system's main memory **225**. According to various aspects of the present invention, frame buffer **214** and video display controller **210** are interconnected within the video data path of computer display system **200**, which is running a presentation application for display on one or both of local LCD device **204** and CRT display device **202**. An external interface bus cable **208** connects CRT display device **202** with video display controller **210**. Frame buffer **214** captures a frame on a video signal generated by a software graphics application (not depicted) and delivered from a central processing unit (CPU) **215** to video memory device **212**. Together, CPU **215**, video memory device **212**, video display controller **210**, and a digital-to-analog converter (DAC) **206** constitute the internal video display data path processing functionality of computer display system **200**.

LCD device **204** provides an onboard video display to a local user, while external CRT display device **202** for provides an alternate video display to an audience, for example. The display capabilities of a personal computer in which computer display system **200** is implemented depend on both the logical circuitry (provided by video display controller **210** and video memory **212**) and the display apparatus connected therewith.

CPU **215** executes program instructions stored in main memory **225**. Data may be manually entered into computer display system **200** via a user input device **218**. In one embodiment, user input device **218** is a keyboard from which soft key functions corresponding to program instructions may be activated. CPU **215** generates data for creating a graphical image for display on either or both of LCD device **204** and CRT display device **202**. Video display controller **210** in conjunction with video memory device **212** converts bit-mapped image data from CPU **215** into a suitably converted video signal.

In typical implementations, video display controller **210** and video memory device **212** will be incorporated on a video adapter board **211** that plugs into a personal computer. The dedicated video storage capacity afforded by video memory device **212** helps ensure that

the host computer's random access memory (RAM) is not depleted by graphic display storage. In addition, although not depicted in **FIG. 2**, video adapter **211** may include its own graphics coprocessor for performing graphics-related computations. In a preferred embodiment, video adapter **211** conforms to a widely utilized standard known as Video Graphics Adapter (VGA) or super VGA. CPU **215** generates a bit-mapped image file that is stored in video memory **212** within video adapter **211**. Video display controller **210** rasterizes the bit-mapped image to produce an digital signal video signal, which drives LCD device **204** and is converted into an analog signal to be utilized by CRT display device **202**.

As depicted in the present embodiment, two distinct buffer address registers **222** and **220** are provided to facilitate controllably independent display modes for local LCD device **204** and external CRT display device **202**, respectively. A video data path for local LCD device **204** is determined in accordance with the contents of frame buffer address register **222**, while the data path for CRT display device **202** is determined in accordance with the contents of frame buffer address register **220**. Video display controller **210** includes two output ports **216** and **217** that deliver display control data to LCD device **204** and CRT display device **202**, respectively, from data pointed to by frame buffer address registers **222** and **220**, respectively. DAC **206** converts digitally encoded images from video display controller **210** into analog signals that can be displayed by CRT display device **202**.

In the depicted embodiment, computer display system **200** is configured to operate in a dual display mode. As utilized herein, "dual display mode" refers to a display configuration wherein both buffer address registers **222** and **220** store pointers from the same frame buffer (frame buffer **214**, for example) such that the same image is displayed on both local LCD device **204** and CRT display device **202**. In contrast, and as explained with reference to **Figures 3-5**, "split display mode" refers to a display configuration whereby the video data path for CRT display device **202** has been altered such that different images may be displayed on LCD device **204** and CRT display device **202**.

In accordance with the depicted embodiment, the default configuration of computer display system **200** includes programming the contents of frame buffer address register **222** to include a pointer from the address of the "active" frame buffer **214**. As defined herein, the "active" frame buffer contains the graphical data that is currently selected for display on local LCD device **204**. Dual display mode is achieved as illustrated in **FIG. 2** by programming the contents of frame buffer address register **220** to include the same pointer as that contained within frame buffer address register **222** (i.e., a pointer from frame buffer **214**). In this configuration, the displays of both local LCD device **204** and CRT display device **202** project the same image as determined by the contents of frame buffer **214**.

Frame buffer address registers **220** and **222** are designated by CPU **215** as the display access registers for CRT display device **202** and LCD device **204**, respectively. In response to a soft key command input from user input device **218** directing activation of dual display mode to CPU **215**, video display controller **210** copies the contents of frame buffer address register **222** to frame buffer address register **220**. Video display controller **210** reads the pointer contents of frame buffer address registers **220** and **222** to obtain the video data contents of frame buffer **214**, which are then displayed on CRT display device **202** and LCD device **204** simultaneously.

Referring now to **FIG. 3**, there is depicted a block diagram illustrating a computer display system **250** configured in split display mode in accordance with a preferred embodiment of the present invention. Split display mode may be desired by a presenter of a sequential graphic display when, for example, the presenter wishes to preview or possibly even modify a next image prior to displaying the next image to the audience. The embodiment depicted in **FIG. 3** allows a presenter to maintain the currently displayed image on external CRT display device **202** while changing the display on local LCD device **204** without the need for duplicate video display controller functionality.

As illustrated in **FIG. 3**, computer display system **250** includes the same hardware functionality as computer display system **200** with an additionally allocated frame buffer **213**. A user wishing to enter split display mode initiates a soft key function command via user input device **218**. The soft key function is programmed to reset the contents of frame buffer address register **220** such that the previously stored pointer from frame buffer **214** are replaced by a pointer from frame buffer **213**. In various embodiments, the soft key utilized to enter split display mode as depicted in **FIG. 3** may include the same or different physical keystroke(s) utilized for enabling the dual display mode configuration illustrated in **FIG. 2**. In a preferred embodiment of the present invention, the soft key utilized to deploy the split display mode configuration shown in **FIG. 3** is programmed to instruct CPU **215** to perform the following sequence of operations with respect to video memory device **212**. First, a frame buffer distinct from primary frame buffer **214** is allocated (i.e., frame buffer **213**). Next, the contents of primary frame buffer **214** are copied to frame buffer **213**. Finally, the pointer from primary frame buffer **214** within frame buffer address register **220** is replaced with an address pointer from frame buffer **213**.

With reference to **FIG. 4**, there is illustrated a flow diagram depicting steps performed by a computer display system configured as shown in **Figures 2** and **3** in selecting dual display and split display modes in accordance with a preferred embodiment of the present invention. The display selection process begins as shown at step **402** and proceeds to step **404** wherein the computer display system is activated. Next, as depicted at step **406**, a frame buffer, such as frame buffer **214**, is allocated and designated as the primary display frame buffer that provides video data to local LCD device **204**. A video data path from primary frame buffer **214** to local LCD device **204** is then established by providing an address pointer within frame buffer address register **222** from primary frame buffer **214** (step **408**).

Proceeding to step **410**, the graphic image file contained within primary frame buffer **214** is locally displayed within LCD device **204**. In the context of a computer-aided presentation, a presenter may wish to provide a dual display wherein the image displayed locally on LCD device **204** is simultaneously displayed on external CRT display device **202**. To this end, and as illustrated at steps **412** and **414**, a pointer is provided within frame buffer address register **220** to point from primary frame buffer **214**. The address pointing configuration resulting from the operations performed at step **414** is depicted in **FIG. 2**. As long as the user wishes to maintain only the local display on LCD device **204** active the process will remain at step **410**.

At any given time during a computer-aided presentation, display independence between local LCD device **204** and external CRT display device **202** may be desirable. For example, the presenter may wish to freeze the current image displayed to the audience on CRT display device **202** while privately viewing and possibly modifying an upcoming display frame image on LCD device **204**. There are numerous additional examples of situations in which it is desired to provide different images on the local and external display devices. If display independence is desired a split mode utility is selected via a softkey user input, and in response thereto, an available and possibly pre-designated buffer within video memory **212** is allocated as an alternate frame buffer (i.e., frame buffer **213**)as depicted at steps **416** and **418**. Also in response to the selection of split display mode at step **416**, the contents of buffer address register **220** are replaced with a pointer from the allocated alternate frame buffer. As a result of the operations depicted at steps **416-422**, the computer display system will be configured as depicted in **FIG. 3**.

With reference to **FIG. 5**, there is depicted a flow diagram illustrating steps performed while selecting alternate split display modes within computer display system **250** in accordance with a preferred embodiment of the present invention. It is assumed that the split display mode process shown in **FIG. 5** is performed after split mode has been selected within computer display system **250** in accordance with the process depicted in **FIG. 4**. The

process begins as shown at steps **502** with **504** with the video data contents of frame buffer **214** being copied to alternate frame buffer **213**. Next, as illustrated at step **506**, the next (M^{th}) display frame is selected by the local user, typically as a keyboard or pointer device user input entry.

As a separate or combined user input command, one of three possible display modes is selected for processing the current and next frame buffer contents. The selection among these options is illustrated at steps **508** (selection of duplicate display mode), **512** (selection of static display mode, and **518** (selection of split sequence display mode). As utilized herein, "duplicate display mode" refers to a display configuration in which the user currently requires a duplicate visual display on local LCD device **204** and external CRT display device **202**, while maintaining independent display capability. In such a case, and as depicted at step **510**, the video data within the M^{th} display frame replaces the current frame buffered within both of frame buffers **214** and **213**.

"Static display mode" is selected when the local user wishes to maintain the current displayed image on either local LCD device **204** or external CRT display device **202** while sequencing to the next display frame on the other display device. As illustrated at steps **512**, **514** and **516**, in response to a user input selecting static display mode, the present content of alternate display frame buffer **213** is maintained while the next display frame is copied to display frame buffer **214**. As long as static mode is maintained, the local user may sequence through and privately view any number display frames on local LCD device **204** while maintaining the same display on external CRT display device **202**. It should be noted that although the present embodiment represents a sequence to a "next" display frame (presumably within a display sequence), one skilled in the art will appreciate that the inventive concept may be readily extended to privately viewing one or more "previous" display frames while the external display remains static.

In addition to the foregoing duplicate and static split display modes, it may often be convenient to provide an option whereby a presenter of a sequential visual display can pre-select a given offset value by which the two displays will automatically be offset as the sequence proceeds. As illustrated at steps **518** and **520**, in response split sequence mode being selected (via a softkey input, for example), the local user inputs a desired sequence offset, N. Proceeding to steps **522** and **524**, M^{th} display frame data is copied to display frame buffer **214** for private viewing by a local user on local LCD device **204**, while the $(M\text{-}N)^{th}$ display frame is copied into display frame buffer **213** for external viewing by the audience. It should be noted that step **524** can be replaced by simply replacing the contents of address register **220** to include a pointer from a display frame buffer that includes the $(M\text{-}N)^{th}$ display frame. The display frames may be stored in a buffer queue (not depicted) within video memory **212**. The sequence is incremented and repeats as depicted at steps **528** and **506** until the end of the display sequence is reached at which time the process terminates as illustrated at steps **526** and **528**. It should be noted that during a display presentation the three split display modes described herein may be combined in any combination at any given step in the display sequence.

A method and system has been disclosed for enabling a dual display mode or a split display mode configuration in a computer-aided display system. Software written according to the present invention is to be stored in some form of computer readable medium, such as memory, CD-ROM or transmitted over a network, and executed by a processor. Alternatively, some of all of the present invention could be implemented in hardware. Although the present invention has been described in accordance with the embodiments shown, one of ordinary skill in the art will readily recognize that there could be variations to the embodiments and those variations would be within the spirit and scope of the present invention. Accordingly, many modifications may be made by one of ordinary skill in the art without departing from the spirit and scope of the appended claims.

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.